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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/038,204	12/21/2001	Daniel T. Colbert	11321-P011C1D3	1758

7590 06/03/2004

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EXAMINER	
LISH, PETER J	

ART UNIT	PAPER NUMBER
1754	

DATE MAILED: 06/03/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/038,204	COLBERT ET AL.	
	Examiner	Art Unit	
	Peter J Lish	1754	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 March 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *112-141* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *125,134,135 and 138-140* is/are allowed.

6)☒ Claim(s) *112-124, 126-133, 136-137* is/are rejected.

7)☒ Claim(s) *141* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

Applicant's arguments with respect to the rejections over 35 U.S.C. 112 have been fully considered and are persuasive. The rejection has been withdrawn. However, it is made of record that the different "types" of nanotubes refer to the different (m,n) indices, or helicities.

Applicant's arguments with respect to the limitation of a substantially two-dimensional array have been fully considered but they are not persuasive. It is unclear as to how a two-dimensional array differs from the bundle structures taught by Kiang et al. To show the difference, applicant points toward Figure 8 of the instant application and the statement in the specification, "substantially two-dimensional array made up of single-walled nanotubes aggregating (e.g., by van der Waals forces) in substantially parallel orientation to form a monolayer extending in directions substantially perpendicular to the orientation of the individual nanotubes." However, one cannot tell what is shown in Figure 8 because it is only a side image rendered from one viewpoint (i.e. is there a depth of nanotubes behind those shown?). It is noted that Fig. 8 appears to show a *linear* array of nanotubes. Additionally, there is no aggregation of nanotubes, as quoted from the specification, shown in Fig. 8. Furthermore, it is unclear as to why the nanotube bundles of Kiang et al. do not meet the limitation of a substantially two-dimensional array.

Applicant's arguments with respect to the application of Zhang et al. have been considered but are moot in view of the new ground(s) of rejection. The argument that the teaching of Zhang et al. regarding the uniformity of the nanotubes within a bundle cannot be applied to the nanotube bundles of Kiang et al. to show inherency because the nanotube bundles

produced by Zhang et al. were produced by a different method from those of Kiang et al. (namely laser ablation vs. arc discharge) is found persuasive. However, newly cited reference to Dresselhaus et al. overcomes this argument.

Applicant's arguments with respect to the rejections over de Heer et al. have been fully considered and are persuasive. The rejections have been withdrawn.

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claim Rejections - 35 USC § 102

Claims 112, 114, 116, 118, 122-124, 127, 129, 131, and 136-137 are rejected under 35 U.S.C. 102(a) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Kiang et al. ("Carbon Nanotubes With Single-Layer Walls").

Kiang teaches that single-walled nanotubes tend to aggregate into bundles. The nanotubes in a bundle run substantially parallel to one another (see Figure 2c). No difference is seen between the bundles of Kiang et al. and the arrays of the instantly claimed invention.

Kiang teaches that the as-grown nanotube bundles are found growing from metal carbide particles, deposited on chamber walls, deposited as a film on the cathode of an arc-discharge apparatus, grown on the cathode tip of an arc-discharge apparatus, and grown on graphite (pages 903-904). Any of the above may be viewed as a substrate to which the nanotube bundles are attached. Kiang teaches the existence of bundles of relatively short single-walled nanotubes having lengths of only 10 to 100 nm (page 905, column 2).

Claims 113, 115, 117, 119, 126, 128, 130, and 132 are rejected under 35 U.S.C. 102(a) as anticipated by Kiang et al. as applied above and with Dresselhaus et al. (Carbon Nanotubes: Synthesis, Structure, Properties, and Applications) to show a state of fact.

Kiang teaches that single-walled nanotubes, made by the arc-discharge process, tend to aggregate into bundles. The nanotubes in a bundle run substantially parallel to one another and appear to have uniform diameters (see Figure 2c). Dresselhaus et al. teach that the nanotube material produced by either laser vaporization or the arc-discharge process appears as a mat of carbon bundles or ropes, such as those taught by Kiang et al. The single-walled nanotubes are arrayed in bundles aligned along a common axis; the bundles are then intertwined to form "ropes" (page 6). Additionally Dresselhaus et al. teaches that the bundles produced by the vaporization and the arc-discharge processes contain nearly perfect single-wall nanotubes of substantially uniform diameter (page 73). Therefore, it is inherent that the bundled single-walled nanotubes of Kiang et al. have a substantially uniform diameter.

Claims 113, 115, 117, 119, 126, 128, 130, 132, and 136-137 are rejected under 35 U.S.C. 102(a) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Kiang et al. as applied above.

Kiang et al. does not explicitly teach that the individual single-walled nanotubes in a bundle have homogenous lengths or helicities in any given region of the bundle. However, it is expected that the tubes in a bundle will have the same helicity or the same length due to corresponding growth conditions. Thus it is expected that a nanotube bundle will have a homogenous length or helicity. Furthermore, it is held that a nanotube must be of the (n, n) or

(m, n) helicity index. A mix is expected to occur due to what is known about growth conditions; bundles of predominantly (n, n) as well as bundles of predominantly (m, n) are therefore expected to occur.

Claim Rejections - 35 USC § 103

Claim 120 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kiang et al. as applied above and further in view of Hiura et al (US 5,698,175) with Sen et al. ("Structures and Images of Novel Derivatives of Carbon Nanotubes...") to show a state of fact.

Kiang does not teach bundles containing a single-walled nanotube having a substituent on the end.

Hiura teaches a process for the purification of carbon nanotubes. The process comprises treating the nanotubes with an aqueous oxidizing agent, such as nitric acid, in solution. The nanotubes are dispersed into the solution and heated in order to selectively react the carbon impurities to dissolve in the liquid phase. The nanotubes are then separated from the liquid by filtering, washing, and drying. Hiura does not explicitly teach that the process be used for the purification of single-walled nanotubes, however, it would have been obvious to one of ordinary skill at the time of invention to apply the treatment of Hiura on a sample containing bundles of single-walled nanotubes, in order to remove impurities.

Sen et al. teaches that when nanotubes are reacted with nitric acid or other oxidizing agents, such reactions are known to result in functional groups, especially –COOH, at the tips (page 493). Substituent groups inherently exist on the ends of nanotubes treated by the process of Hiura et al.

Claims 121 and 133 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kiang et al. as applied to claims 112 and 124 above, and further in view of Green et al. (US 6,090,363).

Green teaches a process whereby the nanotubes are treated and purified in nitric acid. Green additionally teaches that materials, such as a variety of metals, may be endohedrally added to the nanotubes during the purification process.

Green et al. does not explicitly teach that the process be used for the purification of single-walled nanotubes, however, it would have been obvious to one of ordinary skill at the time of invention to perform the treatment of Green et al. on a sample containing bundles of single walled nanotubes, in order to remove impurities and introduce endohedral species.

Allowable Subject Matter

Claim 141 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 125, 134-135, and 138-140 are allowed.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Peter J Lish whose telephone number is 571-272-1354. The examiner can normally be reached on 9:00-6:00 Monday through Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stanley Silverman can be reached on 571-272-1358. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

PL

STUART L. HENDRICKSON
PRIMARY EXAMINER